(Proposal)

Delaware State Implementation Plan Revision

Decommissioning Stage II Vapor Recovery Systems and Requiring Stage I Enhanced Vapor Recovery Systems at Gasoline Dispensing Facilities

Submittal For

U.S. Environmental Protection Agency

Submitted By

Delaware Department of Natural Resources and Environmental Control

November 2019

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Acronym List

AST ---------- Aboveground storage tank
CAA ---------- Clean Air Act Amendments of 1990
CARB -------- California Air Resources Board
CF ---------- Compatibility factor
CPM ---------- Continuous pressure monitoring
EE ---------- Excess vent emissions
EVR ----------Enhanced vapor recovery
GDF ---------- Gasoline dispensing facility
GPM ---------- Gallons per month
GPY ---------- Gallons per year
MFTA -------- Motor Fuel Tax Administration, Delaware Dept. of Transportation
MOVES ------ Motor Vehicle Emissions Simulator model
NAAQS ------ National Ambient Air Quality Standards
NEI ---------- National emission inventory
NESHAP ----- National Emissions Standards for Hazardous Air Pollutants
OBD ---------- Onboard diagnostics
ORVR -------- On-board refueling vapor recovery
RFP ---------- Reasonable further progress
RFG ----------Reformulated gasoline
RVP ----------Reid vapor pressure
TPY ---------- Tons per year
UST ---------- Underground storage tank
VOC ---------- Volatile organic compound
VRS ----------Vapor recovery system
OTR ----------Ozone Transport Region
VMT ---------- Vehicle miles traveled

1. Introduction

Since early 1990s, the ambient air quality in Delaware, in particular in New Castle County of Delaware, has been in nonattainment for the health-based national ambient air quality standard (NAAQS) for the pollutant ground-level ozone (O_3). Because gasoline vapors contain mainly volatile organic compounds (VOC) and contribute to the formation of ground-level ozone in the ambient air, Section 182(b)(3) of the Clean Air Act Amendments of 1990 (CAA) requires states with moderate and higher ozone nonattainment areas to revise their State Implementation Plans (SIP) to require "owners or operators of gasoline dispensing systems to install and operate……a system for gasoline vapor recovery of emissions from the fueling of motor vehicles."

To comply with the above CAA requirement, Delaware has required, since 1993, gasoline dispensing facilities (GDF) in the state to install Stage II vapor recovery systems (VRS) to control gasoline vapor emissions from motor vehicles during refueling processes. Stage II VRS controls gasoline vapor emissions by collecting gasoline vapors displaced from vehicle's gasoline tank during the transfer of gasoline from GDF to vehicle's tanks, and returning the collected vapors to GDF's underground storage tanks (UST) or aboveground storage tanks (AST). Delaware has also required, since 1993, the GDFs to install Stage I VRS for their gasoline storage tanks to control gasoline vapor emissions during gasoline delivery. Stage I VRS controls gasoline vapor emissions by collecting gasoline vapors displaced from GDF's UST or AST when a delivery truck delivers gasoline into the UST or AST, and returning the collected vapors to the tank of the delivery truck. A properly designed Stage I system can also help the UST or AST maintain vapor tight so that the gasoline vapors will not escape from the UST or AST during daily operation of the GDF.

Since 1998, US automobile manufacturers have been required by Section 202(a)(6) of the CAA to install on-board refueling vapor recovery (ORVR) systems on new vehicles. Both Stage II and ORVR systems are effective for controlling gasoline vapor emissions during vehicle refueling. However, vacuum-assist Stage II systems[1] and ORVR systems are incompatible. When such Stage II-equipped GDFs are refueling ORVR-equipped vehicles, the ORVR system will force the Stage II's vacuum pump to pull fresh air into the UST or AST, causing vapor pressure growth in the storage tanks. The vapor pressure growth leads to additional vapor emissions from the storage tanks, especially when those tanks are not vapor-tight.

Due to the functional overlap and incompatibility between the vacuum-assist Stage II systems at GDFs and the ORVR system on vehicles, the US Environmental Protection agency (EPA) issued a final rule in May 2012 (*77* ***FR*** *28772*) allowing states in the Ozone Transport Region (OTR), including Delaware, to remove their GDF's Stage II vapor recovery requirements, provided the overall emissions from the GDFs without Stage II systems do not increase.[2] Section 184(b)(2) of the CAA requires the Administrator of the EPA to identify "control measures capable of achieving emission reductions comparable to those achievable

[1] There are two types of Stage II vapor recovery systems, the vacuum-assist system and the balance system. The Stage II systems installed at Delaware GDFs are all vacuum-assist systems.

[2] Federal Register *77 FR 28772*, May 16, 2012. Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver. https://www.govinfo.gov/content/pkg/FR-2012-05-16/pdf/2012-11846.pdf.

through vehicle refueling controls" and for states that are in OTR to adopt "such [comparable] measures or such vehicle refueling controls."

The EPA's May 2012 rule waived Section 182(b)(3) Stage II requirements by determining that ORVR was in widespread use nationwide. Since Delaware's Stage II systems are all vacuum-assist systems, Delaware is proposing to decommission the Stage II systems installed at all GDFs in Delaware. As an OTR state, however, Delaware is required to include the following elements in its SIP revision regarding decommissioning the Stage II program:

- A demonstration that Delaware will achieve emissions reductions comparable to those that would be realized if the Stage II program remained in place, as required by Section 184(b)(2) of the CAA;

- A demonstration that emissions increases associated with the discontinuation of the Stage II requirement will not contribute to violations of the 2015 ozone NAAQS, as required by CAA Section 110(ℓ).

This document is Delaware's SIP revision to demonstrate that decommissioning Stage II vapor recovery systems in Delaware is consistent with the above Section 184(b)(2) and Section 110(ℓ) requirements. The agency with the direct responsibility for developing and submitting this SIP revision is Division of Air Quality (DAQ), with David Fees, P.E., as the director, within Delaware Department of Natural Resources and Environmental Control (hereafter referred to as "the Department" or "DNREC"). Frank Gao, Ph. D. and P.E., with DAQ, is the project leader and principle author of this SIP revision.

2. Revisions of Delaware Stage I and Stage II Regulations

In September 2015, Division of Air Quality (DAQ) of the Department revised Delaware's Stage II regulation and established certain requirements for existing GDFs to decommission their Stage II systems and for new GDFs to operate without Stage II systems. The revised regulation is **7 DE Admin. Code** 1124, Section 36.0, "Vapor Emission Control at Gasoline Dispensing Facilities" (hereafter referred to as the "2015 Stage II Regulation"). The 2015 Stage II Regulation allowed Delaware GDFs to either decommission Stage II systems or continue operating Stage II systems in an unspecified trial period.[3]

During the trial period, the existing GDFs can choose the option of decommissioning their Stage II systems, and the new GDFs could choose the option of not installing Stage II systems. Such non-Stage II GDFs are required to maintain their gasoline underground storage tanks (USTs) or aboveground storage tanks (ASTs) vapor-tight by installing one of the California Air Resources Board (CARB) approved Stage I enhanced vapor recovery (EVR)

[3] The 2015 Stage II Regulation did not specified the length of the trial period when it was revised in 2015. However, Delaware believed that the vapor emission reduction benefit of maintaining Stage II systems would be diminishing in about 3 years after 2015 due to excess vapor emission caused by functional incompatibility of GDF's vacuum-assist Stage II systems and vehicle's ORVR systems.

systems. To monitor the proper function of the Stage I EVR systems, these stations are further required to: (1) install a continuous vapor pressure monitoring (CPM) system, or (2) perform an annual pressure decay test at no pre-test-repair condition (the so-called "cold condition") and follow other requirements.[4]

After more than 3 years of implementation of the 2015 Stage II Regulation, DAQ started the process to revise the 2015 Regulation in early 2019. The purposes of the revision are to: (1) finalize the deadline for decommissioning all Stage II systems in Delaware, (2) implement necessary requirements for GDFs to ensure that gasoline vapor emissions are well-controlled at both existing and new GDFs, and (3) provide to GDFs flexibilities for adopting new and revised requirements. The proposed regulation is presented in Appendix A of this document, and hereafter referred to as the "2019 Stage II Revision." The 2019 Stage II Revision is expected to become effective in early 2020.

It should be noted that, together with the 2019 Stage II Revision, the 2002 version of 7 **DE Admin. Code** 1124, Section 26, "Gasoline Dispensing Facility Stage I Vapor Recovery" has been revised as well. The purpose of the revision to the 2002 Stage I regulation (hereafter referred to as "the 2019 Stage I Revision") is to establish an effective connection between Section 26 and Section 36, so that the GDFs in Delaware under Section 26 will be subject to the relevant Stage I EVR requirements in the 2019 Stage II Revision. Since the regulated GDFs under both Section 26 and Section 36 are the same, the 2019 Stage I Revision will not have an additional effect on the emission impact analyses in the following sections of this document. The 2019 Stage I Revision is expected to be effective in early 2020.

3. Emission Impact Analysis

This section presents Delaware's analyses for assessing impacts of the 2019 Stage II Revisions on Delaware state-wide GDF VOC emission inventory. The analyses follow the methods and procedures being outlined in the 2012 EPA guidance document, entitled "Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures" (Reference 1, hereafter referred to as the "2012 EPA guidance").

3.1 Conditions and assumptions used in analyses

To facilitate the emission analyses, Delaware used the following conditions and assumptions:

(1) The analyses are conducted for the entire state of Delaware since the requirements in the 2019 Stage II Revision apply to all three counties of Delaware. Although only New Castle County is currently in nonattainment status under the 2015 ozone national air quality standard,

[4] The other requirements include conducting monthly inspection by the station owner or operator, and performing 4 consecutive quarterly retests after necessary repair of the Stage I system if it failed an annual pressure decay test at cold condition (i.e., no repair before or during the test on the test day).

both Kent County and Sussex County will need to continue to maintain their air quality attainment status.

(2) The 2019 Stage II Revision establishes a deadline of December 31, 2021 for decommissioning Stage II systems to coordinate with Delaware's attainment date for the 2015 ozone national ambient air standard. The revision also establishes a deadline of December 31, 2025 for installing Stage I enhanced vapor recovery (EVR) systems in Delaware, to gain additional VOC emission reductions to help Delaware maintain the ambient air quality.[5]

(3) Delaware's 2017 National Emission Inventory (NEI) data on GDF gasoline throughputs, the latest data available to the Department at the time when this document is developed, are used as the base-year data for projecting future years' gasoline throughputs.[6]

(4) Delaware's highway gasoline throughputs in 2005 through 2016 in the report of Federal Highway Administration (FHA) are used in estimating Delaware highway gasoline growth factor from 2017 to 2026.[7]

3.2 Terms used in analyses

Terms used in Delaware's analyses, as defined in the EPA 2012 guidance (Reference 1), include the following:

η_{iuSII} = Stage II VRS in-use control efficiency, which is the current best estimate of the average in-use control efficiency for Stage II VRS in the state when applied to vehicles that are not equipped with ORVR systems. From the publically available data, EPA provides a typical range of 60-75 percent. Delaware selects using the mid-value of this range (i.e., 67.5% or 0.675) in its analysis.

Q_{SII} = Fraction of highway gasoline throughput covered by Stage II VRS, which is the fraction of gasoline being sold through dispensers equipped with Stage II VRS, and expressed as a fraction of 1. The EPA provides a typical range of 0.95-0.97 for states/areas that adopted the 10,000 GPM (gallons per month) exemption criteria for all GDFs. Since Delaware has accepted this criteria for all its GDFs, Delaware selects using the mid-value in this range (i.e., 0.96) in its analyses.

[5] The deadline of December 31, 2025 for installing Stage I EVR systems was determined upon the request from the industry representatives of the existing GDFs, asking for an appropriate length of time to plan their Stage I EVR installation projects, which would involve concrete-breaking, heavy laboring, and capital budgeting.

[6] Personal communication: From Andrea Bayline of Motor Fuel Tax Administration, Division of Motor Vehicles, Delaware Department of Transportation, to Shane Cone of DAQ-DNREC, July 31, 2018, regarding data of highway gasoline uses related to Delaware 2017 NEI report.

[7] Federal Highway Administration, Department of Transportation, 2005 through 2016, Motor Fuel Use of Delaware, at https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm.

Q_{SIIva} = Fraction of highway gasoline throughput dispensed through vacuum-assist type Stage II VRS, which is the fraction of annual gasoline consumption in the state/area dispensed through vacuum-assist Stage II VRS, and expressed as a fraction of 1. All Delaware GDFs, except those with monthly throughputs equal to or smaller than 10,000 GPM, are equipped with the vacuum-assist Stage II systems. Based on its 2017 NEI gasoline throughput data, Delaware uses 0.998 in the analyses (see Table 1 in subsection 3.3 of this document).

Q_{ORVRi} = Fraction of annual gallons of highway motor gasoline dispensed to ORVR-equipped vehicles, where *i* indicates specific calendar years (e.g., 2016, 2017, etc.). Delaware uses the national data presented in Table A-1 in the EPA 2012 guidance. Table A-1 provides the data up to 2020. Delaware uses the linear extrapolation method to estimate the fractions for 2021 through 2026.

CF_i = Compatibility factor, which is an indicator showing increase in gasoline storage tank vent pipe emissions over the normal breathing/emptying loss emissions. Delaware uses the following equation, as provided in the EPA 2012 guidance, to calculate this factor:

$$CF_i = (0.0777)(Q_{ORVRi}) \quad \text{Eq. 1}$$

EE_i = Excess vent emissions (EE) on a lb/1000-gallon basis in the year *i*. Delaware uses the following equation, as provided in the EPA 2012 guidance, to calculate this factor:

$$EE_i = 0.591(Q_{ORVRi}) \quad \text{Eq. 2}$$

η_{ORVR} = In-use control efficiency for vehicle ORVR system. The EPA recommends a value of 0.98 (Reference 1). Delaware accepts this recommended value in its analyses.

For assessing the impacts of Stage II-ORVR incompatibility on Delaware GDF refueling emissions, the following two parameters are calculated using methods provided in the 2012 EPA guidance (Reference 1):

$Increment_i$ = Overall Stage II-ORVR increment in the year *i*. The overall increment identifies the state-wide emission control gain from Stage II installations at GDFs as the ORVR technology phases in. This parameter is a decimal or percent number and will decrease over time while the portion of ORVR-equipped vehicles increases in the fleet. When this parameter turns to a negative number in a specific year, it indicates that the emission reduction benefit from Stage II program diminishes in that year. Removal of Stage II systems from the GDFs is assumed to be necessary after the identified year (usually called the turning point) to

avoid excess emissions due to the incompatibility of Stage II and ORVR systems.

Delta$_i$ = Overall Stage II-ORVR delta. The overall delta is the comparison between the Stage II control efficiency and the ORVR control efficiency with both technologies in place together. This parameter is also a decimal or percent number. When it changes to a negative number, it indicates that the overall ORVR control in the fleet vehicles provides a greater emission reduction benefit than what the Stage II control program provides alone.

In its 2012 guidance, EPA provides the following equations to calculate *Increment*$_i$ and *Delta*$_i$ (Reference 1):

$$Increment_i = (Q_{SII})(1-Q_{ORVRi})(\eta_{iuSII}) - (Q_{SIIva})(CF_i) \quad \text{Eq. 3}$$

$$Delta_i = (Q_{SII})(\eta_{iuSII}) - (Q_{SIIva})(CF_i) - (Q_{ORVRi})(\eta_{ORVR}) \quad \text{Eq. 4}$$

3.3 Impacts of Stage II-ORVR incompatibility and Stage II decommissioning

This subsection presents the impact analyses of Stage II-ORVR incompatibility and Stage II decommissioning on Delaware's VOC emission inventory and its progress of attaining or maintaining the ozone national ambient air quality. Details of data collections and calculations are presented in Appendix B, Table B-1 and Table B-2, of this document.

3.3.1 Delaware 2017 GDF and highway gasoline throughput data

Delaware 2017 GDF groups and their gasoline throughput data are presented in Table 1 below. The data are extracted and summarized from Delaware 2017 NEI report. The original GDF and throughput data in the report were from Motor Fuel Tax Administration, Delaware Department of Transportation (DelDOT) (see Footnote 6).

Table 1. Delaware 2017 GDF throughput data from its 2017 NEI report.

DE GDF Groups by Monthly Throughput (GPM)	**# GDFs in Group**	**Group Annual Throughput (GPY)**	**% Total Throughput**
Large: Greater than 100,000	131	377,350,037	78.3%
Medium: 50,000 to 100,000	87	80,558,014	16.7%
Small: 10,000 to 50,000	60	23,172,569	4.8%
Less than 10,000 (exempt)*	41	1,078,886	0.2%
Total	319	482,159,506	100.0%
Total Throughput of the regulated GDFs (Not including exempt GDFs):		**481,080,620**	**99.8%**

*Delaware's small GDFs with monthly throughputs equal to or less than 10,000 gallons are exempt from the Stage II requirements (per 7 **DE Admin. Code** 1124 Section 26 and Section 36).

3.3.2 Highway gasoline throughput growth factor and ozone season throughput ratio

The growth factor and ozone season ratio for estimating Delaware highway gasoline throughputs in from 2018 to 2026 are estimated using the Federal Highway Administration (FHA) historical data from 2005 to 2016 (see Footnote 7). It should be noted that the future year 2026 is selected for estimating impact of implementing Stage I EVR on future-year VOC emissions after the year 2025 in which all GDFs complete installation of Stage I EVR systems.[8] Details of the growth factor and ozone season ratio are presented in Appendix B, Table B-1 of this document. The data and the results are summarized in Table 2 below.

Table 2. Estimates of highway gasoline use annual growth factor and ozone season ratio.

Year	Annual Throughput 2005-2016	Annual Growth Factor (%)	O_3 Season Throughput Ratio
2005	448,738,393	2.3	0.436
2006	459,168,921	1.4	0.424
2007	465,581,434	(4.2)	0.443
2008	445,870,978	0.6	0.425
2009	448,329,650	1.1	0.440
2010	453,123,412	(3.2)	0.429
2011	438,677,870	(0.4)	0.436
2012	436,962,775	(0.6)	0.442
2013	434,437,714	1.8	0.431
2014	442,398,671	9.2	0.423
2015	482,996,932	4.5	0.443
2016	504,663,537	(4.5)	0.436
	Average:	**0.7**	**0.434**

3.3.3 Predications of highway gasoline throughputs for 2018 to 2026.

Delaware highway gasoline throughputs from 2018 to 2026 are projected, based on the total 2017 throughput in Table 1, using the average growth factor and ozone season ratio in Table 2. The results are presented in Table 3 below.

[8] The 2019 Stage II Revision requires Delaware's GDFs to install the CARB approved Stage I EVR systems by December 31, 2025. For how Delaware determined the deadline of December31, 2015, see Footnote 5.

Table 3. Projections of highway gasoline throughput in 2018-2026.

Year*	Annual Throughput 2017-2026	O_3 Season Throughput 2017-2026
2017	482,159,506	209,219,729
2018	485,368,790	210,612,308
2019	488,599,434	212,014,157
2020	491,851,582	213,425,336
2021	495,125,377	214,845,908
2022	498,420,962	216,275,936
2023	501,738,483	217,715,482
2024	505,078,085	219,164,610
2025	508,439,916	220,623,383
2026	511,824,124	222,091,866

* The 2018-2026 data are projected from the 2017 data which are from Delaware's 2017 NEI report on GDF gasoline throughputs (see Footnote 6).

3.3.4 Determination of turning point of emission benefits

Table 4 presents the calculation results of $Increment_i$ and $Delta_i$ calculations using Eq. 3 and Eq. 4, respectively. Details of the calculations are presented in Appendix B, Table B-1, of this document. The $Delta_i$ values in Table 4 shows that in 2017 Delaware reached a stage where the overall ORVR control in the fleet vehicles provided 30.7% greater (i.e., -0.307) emission reduction benefit than what the Stage II control program provided alone.

Also shown in Table 4, the $Increment_i$ value turned to -0.007 (or -0.7%) at the midpoint of 2017,[9] indicating that the emission reduction benefit from the Stage II program in Delaware diminished in 2017 and started a negative benefit (i.e., causing an actual emission increase) due to its incompatibility with the ORVR control. Beginning with 2017, removal of the Stage II systems at Delaware's GDFs becomes necessary to avoid the incompatibility excess emissions.

[9] As indicated in Section 3.4 of the 2012 EPA guidance (Reference 1), the $Increment_i$ value corresponds to the midpoint of the year *i*.

Table 4. Determination of turning point of emission benefits.

Year	$Increment_i$	$Delta_i$
2012	0.084	-0.174
2013	0.060	-0.209
2014	0.039	-0.240
2015	0.020	-0.267
2016	0.005	-0.289
2017	**-0.007**	**-0.307**
2018	-0.019	-0.324
2019	-0.028	-0.338
2020	-0.036	-0.349
2021	-0.043	-0.360

3.3.5 Estimates of incompatibility impacts on VOC emission inventory

In its 2012 guidance, EPA provides the following equation to estimate the impact of the Stage II-ORVR incompatibility on an area-wide or state-wide VOC emission inventory:

$$Tons_i = (Increment_i)\ (GC_i)\ (EF) \qquad \text{Eq. 5}$$

where, $Increment_i$ is defined in subsection 3.2 above;

GC_i is the projected gasoline consumption (in gallons) for the year *i*. Delaware's state-wide projections in the years after 2017 are presented in Table 3 above;

EF is the uncontrolled displacement refueling emission factor (g/gal). Delaware uses 3.0 g/gal for its 5-month ozone season (May-September), as recommended for Delaware in Table A-7 of the 2012 EPA guidance.

$Tons_i$ is the VOC emission benefits from Stage II program while the ORVR-equipped vehicles continue to increase in the fleet in the year *i*.

Details of using Eq. 5 to calculate emission impacts are presented in Appendix B, Table B-2 of this document. A summary of the calculation results is presented in Table 5 below. Emissions in the O_3 seasons are calculated using Eq. 5 and the ozone season throughputs in Table 3. The annual emissions are calculated by dividing the ozone season emissions with the average ozone season throughput ratio presented in Table 2 ($R_{ozone\text{-}throughput} = 0.434$).

Table 5. Estimates of emission benefits from Stage II after 2016.*

Year	$Tons_i$ (O_3 season)	$Tons_i$ (Annual)
2016	3.74	8.62
2017	-4.96	-11.43
2018	-13.08	-30.14
2019	-19.78	-45.58
2020	-25.55	-58.86
2021	**-30.87**	**-71.13**
2022	-35.75	-82.37
2023	-40.17	-92.55
2024	-44.12	-101.65
2025	-47.59	-109.64
2026	-51.10	-117.74

*Negative benefits in the table indicate emission increases, instead of emission reductions.

From the emission estimates in Table 5, it can be seen that if the vacuum-assist Stage II systems in Delaware were not removed after 2017, emission reduction benefits would be lost, due to their incompatibility with the ORVR systems on the fleet vehicles. For example, in the attainment year 2021 for the 2015 ozone NAAQS, the Stage II systems in Delaware, if not removed, would lead to an emission increase of 30.87 tons in the ozone season ($Tons_{2021\text{-}ozone\text{-}season}$), or 71.13 TPY ($Tons_{2021\text{-}annual}$), in Delaware's 2021 VOC emission inventory.

3.4 Effects of regulatory changes on GDF VOC emissions

3.4.1 Effects of requirements for decommissioning Stage II

As shown in Table 1, the total number of GDFs in Delaware regulated by the Stage II regulation is (319 – 41) = 278. Before the effective date of the 2019 Stage II Revision,[10] 104 GDFs in Delaware have decommissioned or will decommission their Stage II system under the 2015 Stage II Regulation.[11] The ratio of the decommissioned GDFs and the total GDFs is defined as $R_{2015reg}$ = (104/278) = 0.37.

[10] At the time this SIP document is developed (the beginning of the fourth quarter of 2019), the 2019 Stage I and Stage II revisions are expected to be effective by the end of the first quarter of 2020.

[11] At the time this SIP document is developed (the beginning of the fourth quarter of 2019), the permit records of Tank Management Section-DNREC show that 74 GDFs in Delaware have operation permits and 30 GDFs have construction permits.

Since the decommissioned GDFs will not contribute to the incompatibility emission increases in 2021, overall emission increases will be reduced. The ratio $R_{2015reg}$ can be used to estimate the effects of the decommissioned GDFs on the 2021 incompatibility emissions in the ozone season and in the entire year under the 2015 Stage II Regulation. Specifically, the affected 2021 ozone season ($Tons_{2021\text{-}ozone\text{-}season1}$) and annual incompatibility emission increases ($Tons_{2021\text{-}annual1}$) are calculated as:

$$Tons_{2021\text{-}ozone\text{-}season1} = Tons_{2021\text{-}ozone\text{-}season}\,(1 - R_{2015reg}) = 30.87\,(1 - 0.37) = 19.45 \text{ tons}$$

$$Tons_{2021\text{-}annual1} = Tons_{2021\text{-}annual}\,(1 - R_{2015reg}) = 71.13\,(1 - 0.37) = 44.81 \text{ tons}$$

The implementation of the 2019 Stage II Revision will also significantly reduce the incompatibility emissions in 2021. The effect is especially important for reducing the VOC emission in the ozone season (May-September) of 2021 for the attainment of the 2015 ozone standard.

The 2019 Stage II Revision requires all remaining Stage II systems to be decommissioned by the end of 2021. It is estimated that a total of 21 months will be needed to fulfill this requirement after the 2019 Stage II Revision becomes effective (i.e., 9 months in 2020 and 12 months in 2021) (see Footnote 10 for the effective date of the 2019 Stage II Revision). The subtotal number of months before the 2021 ozone season will be 13 (i.e., 9 months in 2020 and 4 months in 2021). The GDFs that decommission their Stage II systems in the subtotal 13 months will not contribute to the incompatibility emissions after May 1, 2021.

Assuming a linear temporal implementation of the decommission requirement of the 2019 Stage II Revision, the ratio of the subtotal month number and the total month number is defined as $R_{2019Revision} = (13/21) = 0.61$, and can be used to estimate the effect of the 2019 Stage II Revision on the Stage II-ORVR incompatibility emissions in the ozone season and the whole year of 2021. Specifically, the remaining 2021 ozone season incompatibility emission increases ($Tons_{2021\text{-}ozone\text{-}season2}$) and annual incompatibility emission increases ($Tons_{2021\text{-}annual2}$) can be estimated as:

$$Tons_{2021\text{-}ozone\text{-}season2} = Tons_{2021\text{-}ozone\text{-}season1}\,(1 - R_{2019Revision}) = 19.45\,(1 - 0.61) = 7.59 \text{ tons}$$

$$Tons_{2021\text{-}annual2} = Tons_{2021\text{-}annual1}\,(1 - R_{2019Revision}) = 44.81\,(1 - 0.61) = 17.48 \text{ tons}$$

3.4.2 Emission reduction benefits of installing Stage I EVR

Before the 2015 Stage II Regulation became effective in September 2015, all GDFs in Delaware were required to install the regular Stage I systems (i.e., Stage I pre-EVR systems). The 2015 Stage II Regulation includes decommissioning Stage II as an optional requirement for Delaware GDFs. If a GDF selects the decommissioning option, however, it has to install a CARB approved Stage I EVR system immediately after decommissioning the Stage II system.

The CARB's studies demonstrated the Stage I EVR systems to be more efficient than the Stage I pre-EVR systems in control of gasoline vapor emissions from GDF's underground or aboveground storage tanks (Reference 2). As mentioned previously, the 2019 Stage II Revision requires Delaware's GDFs to install the CARB approved Stage I EVR systems by the end of 2025 (see Footnote 8).

Estimates of emission differences in 2021 and 2026 between the Stage I pre-EVR requirement and the Stage I EVR requirement are presented in Table 6. In the table, the emission factors of pre-EVR system and EVR system are obtained from Reference 2.[12] The following equations are used for estimating the emissions in Table 6, using the year 2021 for example:

$$Emis_{2021\text{-}Pre\text{-}EVR} = EF_{Pre\text{-}EVR}\,(Throughput_{2021regulated})$$

$$Emis_{2021\text{-}EVR} = EF_{EVR}\,(Throughput_{2021egulated})$$

$$Emis\text{-}Reduction_{2021EVR} = Emis_{2021\text{-}Pre\text{-}EVR} - Emis_{2021\text{-}EVR}$$

where, $Emis_{2021\text{-}Pre\text{-}EVR}$ is the 2021 emission from the Stage I pre-EVR systems;
$Emis_{2021\text{-}EVR}$ is the 2021 emission from the Stage I EVR systems;
$EF_{Pre\text{-}EVR}$ is the emission factor of the Stage I pre-EVR system, 0.38 lbs./kgal;
EF_{EVR} is the emission factor of the Stage I EVR system, 0.15 lbs./kgal;
$Throughput_{2021regulated}$ is the 2021 gasoline throughput for the regulated GDFs, which is 99.8% of the 2021 throughput for all GDFs given in Table 3;
$Emis\text{-}Reduction_{2021EVR}$ is the emission reduction (i.e., benefit) from the Stage I EVR systems over the Stage I pre-EVR systems in 2021.

Calculations of emissions and reduction benefits for the year 2021 using the above equations are shown below:

$$Emis_{2021\text{-}Pre\text{-}EVR} = (0.38\ lbs./kgal)\,(495{,}152{,}377\ gal/yr)\,(99.8\%)\,(tons/2000lbs) = 93.89\ TPY$$

$$Emis_{2021\text{-}EVR} = (0.15\ lbs./kgal)\,(495{,}152{,}377\ gal/yr)\,(99.8\%)\,(tons/2000lbs) = 37.06\ TPY$$

$$Emis\text{-}Reduction_{2021EVR} = 93.89 - 37.06 = 56.83\ TPY$$

Similarly, calculations for the year 2026 are shown below:

$$Emis_{2026\text{-}Pre\text{-}EVR} = (0.38\ lbs./kgal)\,(511{,}824{,}124\ gal/yr)\,(99.8\%)\,(tons/2000lbs) = 97.05\ TPY$$

$$Emis_{2026\text{-}EVR} = (0.15\ lbs./kgal)\,(511{,}824{,}124\ gal/yr)\,(99.8\%)\,(tons/2000lbs) = 38.31\ TPY$$

[12] In Reference 2, CARB uses the term "Phase I" which is equivalent to the term "Stage I" used in this document.

$$\text{Emis-Reduction}_{2026EVR} = 97.05 - 38.31 = 58.74 \text{ TPY}$$

Table 6. Emissions in 2021 and 2026 from implementing Stage I EVR.

Phase I* program		**Phase I Pre-EVR**	**Phase I EVR**
Emission factors (CARB 2013-Revised) (lbs/kgal)		0.38	0.15
Year 2021	DE 2021 throughput of all GDFs (GPY)	495,125,377	
	DE 2021 throughput of regulated GDFs (GPY) (99.8%)	494,135,126	
	Emission estimates in 2021 (TPY)	93.89	37.06
	Emission reduction from EVR in 2021 (TPY)		56.83
Year 2026	DE 2026 throughput of all GDFs (GPY)	511,824,124	
	DE 2026 throughput of regulated GDFs (GPY) (99.8%)	510,800,475	
	Emission estimates in 2026 (TPY)	97.05	38.31
	Emission reduction from EVR in 2026 (TPY)		58.74

* The term "Phase I" is equivalent to Stage I.

As summarized previously in subsection 3.4.1, from September 2015 to the projected effective date of the 2019 Stage II Revision, 104 GDFs in Delaware have installed the CARB approved Stage I EVR systems along with their Stage II decommissioning activities (see Footnote 10 and Footnote 11). The ratio of the Stage I EVR GDFs to the total GDFs is the same as the ratio of the decommissioned GDFs and the total GDFs, that is, $R_{2015reg} = (104/278) = 0.37$.

The emission reduction benefits from the Stage I EVR systems installed before the projected effective date of the 2019 Stage II Revision will contribute to offsetting the remaining incompatibility emissions in 2021 as estimated at the end of subsection 3.4.1. To estimate such reduction benefits, the ratio $R_{2015reg}$ and the ozone season throughput ratio in Table 2 ($R_{ozone\text{-}throughput} = 0.434$) can be used on the 2021 emission reductions in Table 6. Specifically, the EVR emission reduction benefits for the ozone season ($EVR_{Reduction\text{-}2021\text{-}ozone\text{-}season}$) and for the whole year ($EVR_{Reduction\text{-}2021\text{-}annual}$) of 2021 can be estimated as:

$$EVR_{Reduction\text{-}2021\text{-}ozone\text{-}season} = (\text{Emis-Reduction}_{2021EVR})\,(R_{2015reg})\,(R_{ozone\text{-}throughput})$$
$$= (56.83)\,(0.37)\,(0.434) = 9.13 \text{ tons}$$

$$EVR_{Redcution\text{-}2021\text{-}annual} = (\text{Emis-Reduction}_{2021EVR})\,(R_{2015reg}) = (56.83)\,(0.37) = 21.03 \text{ tons}$$

From the above estimates, it is clear that the emission reduction benefits from the Stage I EVR systems installed in 37% GDFs will be more than enough to offset the remaining

incompatibility emission increases, as estimated in subsection 3.4.1 for both the ozone season ($Tons_{2021\text{-}ozone\text{-}season2}$ = 7.59 tons) and the entire year ($Tons_{2021\text{-}annaul2}$ = 17.48 tons).

It can be also seen from Table 6 that implementation of Stage I EVR systems in Delaware by the end of 2025 will provide a VOC emission reduction of 58.74 TPY in 2026 after all regulated GDFs install Stage I EVR systems. The emission reduction benefit will likely increase after 2026 along with the growth of highway gasoline use in the future years. Delaware believes that such a long-term VOC emission benefit will help the state maintain its ozone air quality after it attains the standard in 2021.

4. Summary and Conclusions

A summary of Delaware's analyses of the 2019 Stage I and Stage II Revisions on the vapor emissions from GDFs in Delaware is presented below:

(1) The vacuum-assist Stage II systems installed in Delaware's GDFs lost the control benefit in 2017 due to their incompatibility with the ORVR systems installed on the fleet vehicles.

(2) The Stage II-ORVR incompatibility emissions of VOC from Delaware's GDFs may increase to 30.87 tons in the ozone season or 71.13 tons in the entire year of 2021, which is Delaware's attainment year for the 2015 ozone national ambient air quality standard.

(3) The Stage II systems that are decommissioned under the 2015 Stage II Regulation will reduce the 2021 Stage II-ORVR incompatibility emission increases to 19.45 tons and 44.81 tons for the ozone season and the entire year, respectively.

(4) Implementation of the decommissioning requirement in the 2019 Stage I and Stage II Revisions will further reduce the 2021 Stage II-ORVR incompatibility emissions increases to 7.59 tons and 17.48 tons for the ozone season and the entire year, respectively.

(5) The Stage I EVR systems that are installed under the 2015 Stage II Regulation will provide Delaware 9.13 tons and 21.03 tons emission reduction benefits for the ozone season and the entire year of 2021, respectively. Those reduction benefits will be enough to offset the remaining Stage II-ORVR incompatibility VOC emission increases in the ozone season and the entire year of 2021, as mentioned in (4) above.

(6) Implementation of Stage I EVR requirement by the end of 2025 under the 2019 Stage I and Stage II Revisions will provide Delaware a 58.74 TPY emission reduction benefit in 2026.

(7) Delaware, by implementing the requirements of Stage II decommissioning and Stage I EVR installation in its Stage I and Stage II regulations, will avoid an increase of VOC emissions of 71.13 TPY in 2021 due the Stage II-ORVR incompatibility, and will reduce

VOC emissions by 58.74 TPY in 2026. Overall, Delaware will achieve a total of (71.13 + 58.74) = 129.87 tons of long-existing VOC emission benefit. This long-term benefit will help Delaware maintain its air quality under the ozone air quality standard.

From the above summary, Delaware concludes:

As required by the revisions to 7 **DE Admin. Code** 1124 Section 26 and Section 36, phasing-out Stage II systems in Delaware by the end of 2021 while installing Stage I EVR systems by the end of 2025 at all regulated GDFs in Delaware will result in a decrease in the state-wide VOC emission inventory.

The revised requirements in Sections 26 and 36 will create VOC emission benefits that are not only comparable to what would be realized by the Stage II program alone, but also more than enough to offset the Stage II-ORVR incompatibility excess emissions in 2021. In addition, the revisions will lead to additional long-term VOC emission reductions after 2025, which will assist Delaware to maintain the ozone air quality. Therefore, Delaware's 2019 Stage I and Stage II Revisions meet the requirement of CAA Section 184(b)(2), and are consistent with the conditions of CAA Section 110(ℓ).

References

1. Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures. EPA-457/B-12-001, US Environmental Protection Agency. August 7, 2012.

2. Revised Emission Factors for Gasoline Marketing Operations at California Gasoline Dispensing Facilities. Monitoring and Laboratory Division, California Air Resources Board, December 23, 2013.

Appendix A

7 DE Admin. Code 1124

Section 26.0 Gasoline Dispensing Facility Stage I Vapor Recovery
Section 36.0 Vapor Emission Control at Gasoline Dispensing Facilities

- Current versions at:
  http://regulations.delaware.gov/AdminCode/title7/1000/1100/1124.shtml#TopOfPage

- 2019 revisions at:
  https://dnrec.alpha.delaware.gov/air/permitting/under-development/

Appendix B

Table B-1. Delaware highway gasoline throughput data from 2005 to 2026.

Year	January	Februry	March	April	May	June	July	August	September	October	November	December	Annual 2005-2016	Annual Growth Factor (%)	O_3 Season Throughput Ratio	Annual 2017-2026	O_3 Season Throughput 2017-2026
2005	36,593,072	31,838,690	36,116,924	37,351,880	39,206,919	39,540,994	39,723,586	40,819,404	36,368,817	36,129,477	37,524,315	37,524,315	448,738,393	2.3	0.436		
2006	35,082,190	33,729,104	43,347,514	38,025,659	38,750,370	37,343,113	39,896,637	39,651,753	38,880,228	40,828,098	36,316,806	37,317,449	459,168,921	1.4	0.424		
2007	37,535,748	33,319,211	37,178,147	36,601,962	39,589,133	40,811,240	41,597,256	44,480,332	39,805,330	38,948,877	37,270,413	38,443,785	465,581,434	-4.2	0.443		
2008	35,504,512	34,109,013	32,805,985	39,977,817	37,190,489	36,709,783	40,002,539	39,084,638	36,411,927	38,864,449	37,099,110	38,110,716	445,870,978	0.6	0.425		
2009	35,167,084	32,836,088	36,576,291	37,397,780	39,054,029	38,349,889	40,884,596	41,830,052	37,191,822	37,001,613	35,408,861	36,631,545	448,329,650	1.1	0.440		
2010	35,237,985	29,556,577	36,826,745	39,189,740	39,435,669	38,991,812	42,062,112	43,173,395	30,548,793	46,534,200	35,520,944	36,045,440	453,123,412	-3.2	0.429		
2011	33,330,517	32,626,828	36,534,891	35,576,025	37,466,102	38,233,289	39,916,245	39,877,187	35,855,909	37,131,268	35,313,921	36,815,688	438,677,870	-0.4	0.436		
2012	33,156,307	32,954,027	32,954,051	37,035,196	36,228,585	38,179,528	39,577,718	39,240,805	39,917,113	35,636,314	36,570,011	35,513,120	436,962,775	-0.6	0.442		
2013	36,094,593	34,171,497	31,950,577	36,687,596	35,859,670	38,195,025	37,524,873	39,798,854	35,992,418	37,520,873	35,303,004	35,338,734	434,437,714	1.8	0.431		
2014	33,510,544	32,002,844	36,208,384	37,531,479	39,606,107	26,081,643	41,036,730	34,852,538	45,359,914	35,012,372	42,024,282	39,171,834	442,398,671	9.2	0.423		
2015	36,024,878	32,796,171	37,754,642	38,384,304	45,345,537	40,231,787	43,654,856	45,881,839	38,922,351	47,040,576	37,054,996	39,904,995	482,996,932	4.5	0.443		
2016	37,503,898	36,617,094	45,084,033	43,221,590	43,846,158	42,498,505	46,134,305	46,701,247	40,675,215	41,050,430	41,107,990	40,223,072	504,663,537	-4.5	0.436		
													2005-2016 Average:	**0.7**	**0.434**		
2017																482,159,506	209,219,729
2018																485,368,790	210,612,308
2019																488,599,434	212,014,157
2020																491,851,582	213,425,336
2021																495,125,377	214,845,908
2022																498,420,962	216,275,936
2023																501,738,483	217,715,482
2024																505,078,085	219,164,610
2025																508,439,916	220,623,383
2026																511,824,124	222,091,866

Notes

(1) The 2005-2016 monthly and annual highway gasoline data are from Federal Highway Administration, DOT, at https://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm

(2) Delaware 2017 NEI annual highway gasoline throughput is used as baseline for estimating future-year throughputs.

(3) The 2005-2016 average growth factor (0.007) and O_3 season throughput ratio are used to estimate the annual and O_3 season throughputs for 2018 to 2026.

Table B-2. Delaware GDF Stage II decommissioning impact analyses.

Year	η_{iuSII} *	Q_{SII}	Q_{SIIva}	Q_{ORVRi} **	CF_i	EE_i	η_{ORVR}	$Increment_i$	$Delta_i$	GCi*** (Annual)	GCi*** (O_3 season)	EF(g/gal)	$Tons_i$ (O_3 season)	$Tons_i$ (Annual)
2012	0.675	0.960	0.998	0.777	0.060	0.459	0.980	0.084	-0.174	436,962,775				
2013	0.675	0.960	0.998	0.810	0.063	0.479	0.980	0.060	-0.209	434,437,714				
2014	0.675	0.960	0.998	0.840	0.065	0.496	0.980	0.039	-0.240	442,398,671				
2015	0.675	0.960	0.998	0.865	0.067	0.511	0.980	0.020	-0.267	482,996,932				
2016	0.675	0.960	0.998	0.886	0.069	0.524	0.980	0.005	-0.289	504,663,537	219,023,975	3.0	3.74	8.62
2017	0.675	0.960	0.998	0.903	0.070	0.534	0.980	-0.007	-0.307	**482,159,506**	209,219,729	3.0	**-4.96**	**-11.43**
2018	0.675	0.960	0.998	0.919	0.071	0.543	0.980	-0.019	-0.324	485,368,790	210,612,308	3.0	-13.08	-30.14
2019	0.675	0.960	0.998	0.932	0.072	0.551	0.980	-0.028	-0.338	488,599,434	212,014,157	3.0	-19.78	-45.58
2020	0.675	0.960	0.998	0.943	0.073	0.557	0.980	-0.036	-0.349	491,851,582	213,425,336	3.0	-25.54	-58.86
2021	0.675	0.960	0.998	0.953	0.074	0.563	0.980	-0.043	-0.360	495,125,377	214,845,908	3.0	-30.87	-71.13
2022	0.675	0.960	0.998	0.962	0.075	0.569	0.980	-0.050	-0.369	498,420,962	216,275,936	3.0	-35.74	-82.37
2023	0.675	0.960	0.998	0.970	0.075	0.573	0.980	-0.056	-0.378	501,738,483	217,715,482	3.0	-40.16	-92.55
2024	0.675	0.960	0.998	0.977	0.076	0.577	0.980	-0.061	-0.385	505,078,085	219,164,610	3.0	-44.11	-101.65
2025	0.675	0.960	0.998	0.983	0.076	0.581	0.980	-0.065	-0.392	508,439,916	220,623,383	3.0	-47.58	-109.64
2026	0.675	0.960	0.998	0.989	0.077	0.584	0.980	-0.070	-0.398	511,824,124	222,091,866	3.0	-51.09	-117.74

Notes:

* η_{iuSII} is the EPA's typical value of 0.675 in its 2012 guidance (Reference 1).

** Q_{ORVRi} between 2012 and 2020 are from Table A-1 of EPA's 2012 guidance (Reference 1), and are extrapolated for 2021 and later years using linear increase assumption.

*** The 2012-2016 annual data are from FHA (Table B-1), the 2017 data are from Delaware 2017 NEI (Footnote 3), and the 2018-2026 data are estimated with the average growth factor from the 2005-2016 data (Table B-1). The ozone season data of 2018-2026 are estimated with the average seasonal ratio from the 2005-2016 data (Table B-1).